BROADBAND DIPOLE ANTENNA TO BE WORN BY A USER AND ASSOCIATED METHODS

Field of the Invention

[0001] The present invention relates to the field of communications, and, more particularly, to an antenna that may be worn by a user.

Background of the Invention

[0002] Portable radio communications are widely used to enable coordination between spaced apart users, such as policemen, fireman, or military personnel, for example. U.S. Patent No. 2,576,128 to Lense issued November 27, 1951 discloses an early version of a man-pack antenna, such as for a soldier, that is in the form of a dipole including upper and lower dipole elements. These elements are centrally fed adjacent the waist of the user and extend upwardly toward the user's shoulder and downwardly to the user's knee. Such a large antenna may simply be too unwieldy for many applications.

[0003] A more advanced type of portable radio is known as the mini-manpack radio, such as the RF-5800V-HH VHF radio offered by Harris RF Communications Division of Rochester, New York. The five watt output mini-manpack handheld radio may be carried on a rear pack of the user. A conventional blade antenna extends upwardly from the

radio. The user removes the radio from the pack and holds the radio in his hand during use.

[0004] In other similar portable radios, a short flexible rubber duck antenna may be used, however, performance may not be as good as with the blade antenna. Thales Defence Communications of the United Kingdom offers the Panther P (BCC 69) VHF frequency hopping secure EPM transceiver with such a relatively short rubber duck antenna. A long whip antenna may provide better performance, but may be unwieldy for the user. Accordingly, the blade antenna has served as a good compromise. Unfortunately, all these antenna types require a counterpoise provided by the radio itself. In addition, electromagnetic noise from interferers may limit sensitivity of the receiver of the radio.

[0005] Other approaches have been described for providing an antenna that is wearable by a user. For example, U.S. Patent No. 6,590,540 to Adams et al. discloses RF elements attached to a garment so that the RF elements each form a band when the garment is worn. A shorting strap electrically connects the first and second RF elements on the back side of the garment. Unfortunately, such an antenna may not be suitable for longer range communications.

[0006] U.S. Patent No. 4,730,195 to Phillips et al. discloses a shortened wideband antenna sleeve dipole antenna including a helically wound upper radiating element and an inductively loaded lower radiating sleeve element to reduce the linear size of the antenna. A helically wound feed coaxial transmission line is within the sleeve element. A matching network at the antenna feed point provides capacitive reactance above the

antenna resonant frequency and inductive reactance below the antenna resonant frequency so that an impedance match is made between the feed coaxial transmission line and dual band performance is obtained.

[0007] U.S. Patent No. 5,949,383 to Hayes et al. discloses an antenna formed on a substrate and including a center feed point. The feed section includes an RF input line and a ground line extending along the substrate and a balun extends along the substrate between the first radiating element and the ground line. Such an antenna may be not meet the durability requirements to be worn by a user or have sufficient power handling capability for longer range communication.

Summary of the Invention

[0008] In view of the foregoing background, it is therefore an object of the present invention to provide an antenna that may be worn by a user and that provides good performance over a wide frequency band.

[0009] This and other objects, features and advantages in accordance with the present invention are provided by an antenna comprising a dipole feed, a first dipole element connected to and extending outwardly from the dipole feed, a transmission line extending from the dipole feed in an opposite direction, and a flexible electrically conductive sleeve surrounding the transmission line and connected to and extending outwardly from the dipole feed. The electrically conductive sleeve may thus serve as a second dipole element and as a balun for the antenna. The antenna may by removably fastened to a garment of the user by at least one fastener to define an antenna assembly. The

antenna assembly may be coupled to a radio also carried by the user to define a portable communications system. To enhance broadband performance, the dipole feed may include a broadband matching network, and the antenna may include a noise filter coupled to the transmission line adjacent an end of the flexible electrically conductive sleeve opposite the dipole feed.

[0010] The noise filter may comprise at least one ferrite body coupled to the transmission line. In addition, the noise filter may also include a dielectric housing surrounding the at least one ferrite body. The noise filter and broadband matching network cooperate to provide broadband performance in a mechanically compact and robust unit.

[0011] The flexible electrically conductive sleeve may also be shape-retaining when formed into a shape having at least one bend therein. Accordingly, if the user were lying down, the conductive sleeve could be temporarily bent at a ninety degree angle so that the first dipole element remained vertically oriented for better performance. The flexible electrically conductive sleeve may comprise a pair of spirally wound, interlocking, electrically conductive elements, for example, to provide this shape-retaining property.

[0012] The first dipole element could also comprise a flexible electrical conductor. This flexible electrical conductor would not typically be shape retaining upon bending; rather, the flexible antenna could be flexed, but would be biased back to the straight position. The antenna may also include a connector coupled to an end of the transmission line opposite the dipole feed. The transmission line extending through the flexible sleeve

may comprise a coaxial transmission line coupled to this connector.

[0013] The at least one fastener for removably fastening the antenna to the garment of the user may comprise a pair of fasteners adjacent opposing ends of the flexible electrically conductive sleeve. Each fastener may include an Alice clip to connect to the garment of the user, an Alice clip mounting bracket connected to the Alice clip, and a quick release knob carried by the Alice clip mounting bracket.

[0014] A method aspect of the invention is for making the antenna as described briefly above. The method may include coupling a first dipole element to and extend outwardly from a dipole feed in a first direction; coupling a transmission line to extend from the dipole feed in a second direction opposite the first direction; and providing a flexible electrically conductive sleeve surrounding the transmission line and coupled to and extending outwardly from the dipole feed to serve as a second dipole element and as a balun. The method may also include coupling a noise filter to the transmission line adjacent an end of the flexible electrically conductive sleeve opposite the dipole feed.

Brief Description of the Drawings

[0015] FIG. 1 is a rear view of a user carrying a communication system including the antenna in accordance with the present invention.

[0016] FIG. 2 is an enlarged cross-sectional view through the noise filter of the antenna as shown in FIG. 1.

[0017] FIG. 3 is an enlarged cross-sectional view of a portion of the flexible electrically conductive sleeve of the antenna as shown in FIG. 1 and illustrating the sleeve in a temporarily bent shape.

[0018] FIG. 4 is a greatly enlarged cross-sectional view through a sidewall portion of the flexible electrically conductive sleeve of the antenna shown in FIG. 1.

[0019] FIG. 5 is a schematic electrical diagram for a broadband matching network of the dipole feed of the antenna as shown in FIG. 1.

Detailed Description of the Preferred Embodiments

[0020] The present invention will now be described more fully hereinafter with reference to the accompanying drawings in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the illustrated embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout, and prime notation is used to indicate similar elements in alternate embodiments.

[0021] Referring initially to FIG. 1, the components of a portable communications system **20** in accordance with the invention are now described. The system **20** includes a radio **21**, and an antenna assembly **22** connected to the radio. The radio **21** may be a portable unit, such as the model RF-5800V-HH that is a small, lightweight VHF handheld radio offered by Harris RF Communications

Division of Rochester, New York, for example. The RF-5800V-HH operates over a broad frequency range of 30-108 MHz. Other possible frequencies may be used by the radio **21**, such as, for example, the 420-450 MHz band.

[0022] The antenna assembly **22** includes an antenna **25**, a pair of upper and lower fasteners **26a, 26b** and a coaxial cable **27** that connects the antenna **25** to the radio **21**. Each of the fasteners **26a, 26b** illustratively includes a conventional Alice clip **30a, 30b** that removable connects typically to webbing or a vest (not shown), for example, or other garment worn by the user **35**. For clarity of explanation, the fasteners **26a, 26b** are illustrated in side view, that is rotated ninety degrees from the actual attached position as will be appreciated by those skilled in the art.

[0023] Each fastener **26a, 26b** illustratively includes an Alice clip mounting bracket **31a, 31b** connected to the Alice clip **20a, 30b**, and a quick release knob **32a, 32B** carried by the Alice clip mounting bracket. Of course, other configurations of fasteners **26a, 26b** are also contemplated by the present invention to permit wearing of the antenna **25** by the user **35**.

[0024] The user **35** may also sometimes wish to remove the antenna **35** and raise it to a higher position, for example, for better range. The fasteners **26a, 26b** provide such flexibility to the user **35** as will be appreciated by those skilled in the art. In other embodiments, only a single fastener, or more than two fasteners may be used.

[0025] The antenna **25** includes a dipole feed illustratively comprising a broadband matching network **40** shown adjacent the upper fastener **26a**. This broadband

matching network **40** is further described below with reference to FIG. 5 and helps provide broadband performance for the antenna **25**.

[0026] The antenna **25** also includes a first dipole element **41** extending upwardly from the dipole feed matching network **40**. This first dipole element **41** may be formed of a series of progressively longer strip-shaped conductors to provide flexibility to the element as will be appreciated by those skilled in the art. Accordingly, the first dipole element **41** may be folded for storage and transportation, but when released will spring to the fully extended position. For the VHF range described above, this first dipole element may have a length of about thirty-six inches, for example.

[0027] The antenna **25** also illustratively includes a transmission line **44** extending from the dipole feed broadband matching network **40** in a downward direction. In other words, the transmission line extends in a second direction opposite the first direction of the first dipole element **41**. The antenna **25** also comprises a flexible electrically conductive sleeve **45** surrounding the transmission line **44** and connected to and extending outwardly from dipole feed matching network **40**. This flexible electrically conductive sleeve **45** serves as a second dipole element and also as a balun to couple the unbalanced transmission line **44** to the dipole antenna elements as will be appreciated by those skilled in the art. For the VHF range described above, this flexible conductive sleeve **45** may have a length of about twenty-four inches, for example.

[0028] The antenna **25** also includes a noise filter **46** coupled to the transmission line **44** adjacent the lower

end of the flexible electrically conductive sleeve **45**. A connector **28** terminates the transmission line **44** at the noise filter **46** as shown. The connector **28** may be a BNC connector or any of a variety of suitable connectors as will be appreciated by those skilled in the art. A mating rotatable connector **29** illustratively connects the jumper coaxial cable **27** to the connector **28** at the noise filter **46**. The rotatable connector **29** may permit the user **35** to swing the coaxial cable **27** to either the right or left side of his body for comfort or convenience. Other pairs of mating connectors, not shown, may be provided along the length of the jumper coaxial cable **27** in some embodiments.

[0029] This noise filter **44** reduces interfering noise delivered from the antenna **25** to the receiver in the radio **21** as will be appreciated by those skilled in the art. Referring briefly to FIG. 2, one embodiment of a suitable noise filter **46** is described. More particularly, the illustrated noise filter **46** includes a cylindrical dielectric housing **47** and a plurality of ferrite beads or bodies **48a**, **48b** surrounding the transmission line **44** and contained within the housing. Other configurations of noise filters are also contemplated by the present invention and will be apparent to those of skill in the art.

[0030] Referring now additionally to FIGS. 3 and 4, other aspects of the antenna **25** are now described. The transmission line **44** is illustratively provided by a coaxial arrangement of conductors. In particular, the transmission line **44** includes an inner conductor **50**, a dielectric layer **51** surrounding the inner conductor, and an outer conductor **52** surrounding the dielectric layer.

The flexible conductive sleeve **45** surrounds the transmission line **44** and is spaced therefrom by another dielectric layer **53** in the illustrated embodiment. Although the dielectric layer **53** is shown filing the space between the outer conductor **52** and the sleeve **45**, in other embodiments the dielectric layer may be a thin layer on the outer conductor, or on the inside surface of the sleeve, and a space or air gap left between the thin dielectric layer and the adjacent conductive portion as will be appreciated by those skilled in the art.

[0031] The flexible electrically conductive sleeve **45** may also be shape-retaining when formed into a shape having at least one bend therein, such as shown by the ninety degree bend in FIG. 3. This bend is at the upper portion of the flexible electrically conductive sleeve **45** between the upper fastener **26a** and the dipole feed matching network **40**. Accordingly, if the user were oriented in a prone position, the conductive sleeve **45** could be temporarily bent at a ninety degree angle so that the first dipole element **41** remained vertically oriented for better performance. It should be noted that the electrically conductive sleeve **45** may be readily bent by the user **35** to conform to his body. The sleeve **45** will also flex during movement by the user **35** so as not to be restrictive.

[0032] The flexible electrically conductive sleeve **45** may be formed of a solid conductor. In another preferred embodiment as shown in FIG. 4, the flexible sleeve **45'** may comprise a pair of spirally wound, interlocking, electrically conductive elements **45a'**, **45b'**, for example. Other configurations are also

envisioned as will be appreciated by those skilled in the art.

[0033] Turning now to FIG. 5, an embodiment of a dipole feed broadband matching network **40** is now described. The network **40** includes a three winding transformer **T1** connected across the dipole elements **41** and **45**. A first capacitor **C1**, a first inductor **L1**, and a third inductor **L3** are connected in series between the inner conductor of the input **IN** and the transformer **T1**. A second capacitor **C2** and second inductor **L2** are connected in parallel with each other and across the input of transformer **T1** between the first and third inductors **L1, L3**. The values of the various components is dependent on the frequency range of interest as will be appreciated by those skilled in the art without the need for further discussion. Other broadband matching networks **40** are also contemplated by the present invention. The illustrated network **40** has an advantage in that no resistors are used and therefore efficiency is higher than would otherwise result.

[0034] A method aspect of the invention is for making the antenna **25** as described herein. The method may include coupling a first dipole element **41** to and extend outwardly from a dipole feed **40** in a first direction; coupling a transmission line **44** to extend from the dipole feed in a second direction opposite the first direction; and providing a flexible electrically conductive sleeve **45** surrounding the transmission line and coupled to and extending outwardly from the dipole feed to serve as a second dipole element and as a balun. The method may also include coupling a noise filter **46** to the transmission line **44** adjacent an end of the flexible

electrically conductive sleeve **45** opposite the dipole feed **40**.

[0035] Many modifications and other embodiments of the invention will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Accordingly, it is understood that the invention is not to be limited to the embodiments disclosed, and that other modifications and embodiments are intended to be included within the spirit and scope of the appended claims.